CLAIMS

We claim:

1. A spin-valve structure comprising a first free ferromagnetic layer and a second free ferromagnetic layer and a spacer layer positioned between said first and second free ferromagnetic layers, wherein said first free ferromagnetic layer is positioned on a conducting substrate with an insulating barrier layer therebetween.

2. The spin-valve structure as recited in claim 1, wherein said insulating layer provides a barrier weak enough for having electrical transport during electroplating and high enough for confining electrical currents in the layers during operation of the spin-valve structure.

3. The spin-valve structure as recited in claim 1, wherein said spacer layer is selected from the group consisting of a metal layer, an antiferromagnetic layer, an insulating layer, a semimetal and a conductive semiconductor layer or any combination thereof or any multilayer structure of any of the layers of said group.

4. A spin-valve structure comprising a first free ferromagnetic layer and a second free ferromagnetic layer and a spacer layer positioned between said first and second free ferromagnetic layers, wherein said first free ferromagnetic layer is positioned on a substrate, said substrate having a lattice structure, said first free ferromagnetic layer having a lattice structure being influenced by the lattice structure of said substrate.

5. The spin-valve structure as recited in claim 4, wherein said spacer layer is selected from the group consisting of a metal layer, an antiferromagnetic layer, a semimetal layer and a conductive semiconductor layer or any combination thereof or any multilayer structure of any of the layers of said group.

6. A spin-valve structure comprising a first free ferromagnetic layer and a second free ferromagnetic layer and third layer positioned between said first and second free

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

ferromagnetic layers, wherein said third layer comprises a layer selected from the group consisting of an antiferromagnetic layer, a metal layer, a semimetal layer and a conductive semiconductor layer, and wherein said first free ferromagnetic layer is positioned on a substrate forming an electrical barrier with a ferromagnetic layer being deposited thereon.

7. The spin-valve structure as recited in claim 6, wherein said first free ferromagnetic layer is positioned on a semiconductor substrate.

8. The spin-valve structure as recited in claim 7, wherein said first free ferromagnetic layer is in direct contact with said semiconductor substrate.

9. The spin-valve structure as recited in claim 6, wherein between said first and second free ferromagnetic layers, there is a sequence of layers comprising at least two magnetic layers with a nonmagnetic layer therebetween.

10. The spin-valve structure as recited in claim 6, wherein between said first and second free ferromagnetic layers, there is a layer selected from the group consisting of an artificial antiferromagnetic layer and a synthetic antiferromagnetic layer.

11. The spin-valve structure as recited in claim 7, wherein said semiconductor substrate is a substrate selected from the group consisting of a GaAs substrate, a Si substrate, a Ge substrate, and a SiGe substrate.

12. The spin-valve structure as recited in claim 6, wherein said first free ferromagnetic layer comprises a material selected from the group consisting of Co, NiFe and CoFe or a mixture thereof.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

13. The spin-valve structure as recited in claim 6, wherein said second free ferromagnetic layer comprises a material selected from the group consisting of Co, NiFe and CoFe or a mixture thereof.

14. The spin-valve structure as recited in claim 13, wherein said first free ferromagnetic layer comprises a material selected from the group consisting of Co, NiFe and CoFe or a mixture thereof.

15. The spin-valve structure as recited in claim 7, wherein the first free ferromagnetic layer that is positioned on said semiconductor substrate has a different coercivity than the second free ferromagnetic layer.

16. The spin-valve structure as recited in claim 7, wherein the first free ferromagnetic layer that is positioned on said semiconductor substrate has a different anisotropy than the second free ferromagnetic layer.

17. The spin-valve structure as recited in claim 16, wherein the first free ferromagnetic layer that is positioned on said semiconductor substrate has a different coercivity than the second free ferromagnetic layer.

18. The spin-valve structure as recited in claim 7, wherein the first free ferromagnetic layer that is positioned on said semiconductor substrate has a higher coercivity than the second free ferromagnetic layer.

19. The spin-valve structure as recited in claim 6, wherein the substrate defines a structure, and wherein magnetic and structural properties of said first free ferromagnetic layer are influenced by the structure of said substrate.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

20. The spin-valve structure as recited in claim 7, wherein the semiconductor substrate defines a surface, and wherein magnetic and structural properties of said first free ferromagnetic layer are influenced by conditions of the surface of the semiconductor substrate.

21. The spin-valve structure as recited in claim 20, wherein the substrate defines a structure, and wherein the magnetic and structural properties of said first free ferromagnetic layer are influenced by the structure of said substrate.

22. The spin-valve structure as recited in claim 7, wherein the semiconductor substrate defines a lattice structure, and wherein magnetic and structural properties of said first free ferromagnetic layer are influenced by the lattice structure of the semiconductor substrate.

23. The spin-valve structure as recited in claim 6, wherein said electrical barrier is selected from the group consisting of a Schottky Barrier and a Tunnel Barrier.

24. The spin-valve structure as recited in claim 6, wherein said electrical barrier prevents shunting currents and protects said spin-valve structure against electrostatic discharge during operation of the spin-valve structure.

25. The spin-valve structure as recited in claim 6, wherein said third layer comprises an antiferromagnetic layer, and wherein said antiferromagnetic layer comprises Cu layers and Co layers positioned therebetween, said Cu layers being thin enough to increase magnetic coupling between said Co layers.

26. The spin-valve structure as recited in claim 25, wherein the layers of said antiferromagnetic layer act as a single hard layer.

27. The spin-valve structure as recited in claim 6, wherein said spin-valve structure is a part of a magnetic memory device.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

28. The spin-valve structure as recited in claim 27, wherein said magnetic memory device has more than two memory states.

29. The spin-valve structure as recited in claim 27, wherein said magnetic memory device has means for being programmed using current pulses of predefined magnitude and pulse width.

30. The spin-valve structure as recited in claim 29, wherein said current pulses are of a fixed magnitude and a variable pulse width.

31. The spin-valve structure as recited in claim 29, wherein said current pulses are of a variable magnitude and a fixed pulse width.

32. A magnetic memory device comprising a spin-valve structure as recited in claim 6.

33. The magnetic memory device as recited in claim 32 having more than two memory states.

34. The magnetic memory device as recited in claim 32, further comprising means for being programmed using current pulses of predefined magnitude and pulse width.

35. The magnetic memory device as recited in claim 34, wherein said current pulses are of a fixed magnitude and a variable pulse width.

36. The magnetic memory device as recited in claim 34, wherein said current pulses are of a variable magnitude and a fixed pulse width.

37. A method for producing a spin-valve structure, comprising electrodepositing said spin-valve structure on a substrate.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

38. The method as recited in claim 37, wherein said spin-valve structure has a first free ferromagnetic layer and wherein said substrate forms a barrier with said first free ferromagnetic layer.

39. The method as recited in claim 37, wherein said substrate is a semiconductor substrate.

40. The method as recited in claim 37, wherein electrodepositing said spin-valve structure on a substrate comprises the following steps:

electrodepositing a first ferromagnetic layer on a semiconductor substrate;

electrodepositing a spacer layer on the first ferromagnetic layer; and

electrodepositing a second ferromagnetic layer on the spacer layer.

41. The method as recited in claim 37, wherein electrodepositing said spin-valve structure on a substrate comprises the following steps:

electrodepositing a first ferromagnetic layer on a semiconductor substrate;

electrodepositing a first nonmagnetic layer on the first ferromagnetic layer;

electrodepositing a third layer on the first nonmagnetic layer, wherein the third layer is selected from the group comprising an antiferromagnetic layer, a metal layer, a semimetal layer and a conductive semiconductor layer;

electrodepositing a second nonmagnetic layer on the third layer; and

electrodepositing a second ferromagnetic layer on the second nonmagnetic layer.

42. The method as recited in claim 41, wherein said spin-valve structure forms a first free ferromagnetic layer and wherein said substrate forms a barrier with said first free ferromagnetic layer.

43. The method as recited in claim 41, wherein said steps are performed in a single electrolyte bath.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

44. The method as recited in claim 41, wherein said electrolyte bath comprises several elements, said elements being selected for deposition by a predetermined applied electrodeposition voltage.

45. The method as recited in claim 44, wherein said semiconductor substrate defines a substrate surface structure, and wherein said method further comprises changing said substrate surface structure before electrodepositing said spin-valve structure.

46. The method as recited in claim 44, further comprising selecting a substrate surface structure for said semiconductor substrate before electrodepositing said spin-valve structure.

47. A method comprising using a spin-valve structure as in claim 1 as a sensing element for contactless position, distance and movement sensing.

48. A method comprising:

producing a spin-valve structure by a method as recited in claim 37; and

using the spin-valve structure as a sensing-element for contactless position, distance and movement sensing.

49. A method comprising using a spin-valve structure as in claim 1 as a sensing element for angular position sensing.

50. A method comprising:

producing a spin-valve structure by a method as recited in claim 37; and

using the spin-valve structure as a sensing-element for angular position sensing.

51. A method comprising using a spin-valve structure as in claim 1 to indirectly measure physical parameters through a change in resistance of the multilayer structure.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

52. A method comprising:

producing a spin-valve structure by a method as recited in claim 37; and

using the spin-valve structure to indirectly measure physical parameters through a change in resistance of the multilayer structure.

53. A method comprising using a spin-valve structure as in claim 1 as a magnetic device in a magnetic memory circuit for building a Magnetic Random Access Memory.

54. A method as claimed in claim 53, wherein said magnetic device has a multivalue memory.

55. A method comprising:

producing a spin-valve structure by a method as recited in claim 37; and

using the spin-valve structure as a magnetic device in a magnetic memory circuit for building a Magnetic Random Access Memory.

56. A method as claimed in claim 55, wherein said magnetic device has a multivalue memory.

57. A method comprising using a spin-valve structure as in claim 1 as an element of a logic gate in a logic device.

58. A method comprising:

producing a spin-valve structure by a method as recited in claim 37; and

using the spin-valve structure as an element of a logic gate in a logic device.

59. A method of operating the spin-valve structure as recited in claim 1, comprising said insulating barrier layer confining currents in-plane.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001

60. A method of operating the spin-valve structure as recited in claim 1, comprising an applied voltage over said insulating barrier layer allowing currents to cross said insulating barrier layer.

McDONNELL BOEHNEN
HULBERT & BERGHOFF
300 SOUTH WACKER DRIVE
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 913-0001